refreshable tactile graphics display technology and design concepts for implementation and use of extended tactile graphic arrays. For an extended tactile graphic array with thousands of pins, major cost saving can be achieved by using each actuator to drive multiple pins via a scanning process. A high-speed repetitive scan that continually refreshes all the pins is conceivable, and may provide benefits for the depiction of moving pictures, but the most cost effective approach at present is one in which a slower scan is used and the pins are retained in place when not being driven by the actuators. The pins are therefore set into place by the operation of the actuators, remain in place as they are read, and are later reset to a default position. The number of actuators needed can be reduced by a factor of hundreds or more compared to the conventional approach of one actuator per pin. It is possible utilizing the foregoing to provide a practical implementation in which an extended tactile graphic array is driven using only a single actuator.

[0095] The primary intended application for the apparatus and method of this invention is a computer driven refreshable tactile graphic array for the display of tactile images for blind and visually impaired users. The technology encompasses both two-level display (each pin either extended or not extended), and multi-level systems for the display of relief images. The display of Braille text (of either standard or non-standard dimensions) is an important additional function of this technology, and an alternate implementation with pin spacing for Braille can be optimized for Braille, with graphics as a secondary function. Implementation options include a display screen (or matrix) that can be removed while retaining the written tactile graphic image, a very low cost screen that is written directly by the user rather than by computer-controlled actuators, and a display that can also create permanent hardcopies of the displayed image.

What is claimed is:

1. An extended refreshable tactile graphic array apparatus for tactile display comprising:

a display surface having a pin array of at least hundreds of movable pins maintained thereat;

pin retention means for holding pins in a position when moved; and

actuating means for selectively moving pins in said pin array between at least first and second positions, a single actuator of said actuating means for moving multiple said pins in said pin array.

2. The apparatus of claim 1 wherein said actuating means includes a selected number of said single actuators to as few as one said single actuator, and wherein said pin retention means includes two-stage pin retention having a temporary retention for holding said pins temporarily in place as said pins in said pin array are being moved by said actuating means and a locking for maintaining establishment of pin positions without continued influence by said actuating means as a user senses the tactile display.

3. The apparatus of claim 1 wherein said pin array is configured in one of a rectangular pin array, a staggered pin array, and an array with pin spacing that includes a pattern configured for display of standard or near-standard dimension Braille text so that said apparatus supports display of both standard or near-standard dimension Braille text and high resolution tactile graphics.

4. The apparatus of claim 1 wherein said actuating means includes a vector drawing mechanism in which said single actuator can be moved along specified vectors for selected movement of any of said pins to generate a tactile graphic image for the entire said pin array.

5. The apparatus of claim 1 wherein said pins include enlarged heads at one end of a shaft and surface features at said shaft cooperative with said pin retention means to enable control of pin position, and wherein said surface features are sufficient to allow each of pins to be moved to a selected one of a plurality of elevations with said enlarged heads a selected distance above said display surface.

6. The apparatus of claim 1 further comprising means for moving all of said pins to a default position.

7. The apparatus of claim 1 wherein said display surface and said pin retention means are mounted together in a stacked matrix, said stacked matrix detachable from said apparatus with a tactile graphic image displayed thereat maintained, whereby a user can use said actuating means with different stacked matrices to produce multiple display surfaces having different tactile graphic images thereat for simultaneous access.

8. An extended refreshable tactile graphic array apparatus for scanned tactile display comprising:

a multiplicity of movable pins, each pin including a shaft between an enlarged head and an end;

a matrix of stacked elements including a display surface element and a pin retention element for holding pins in a position when moved, said display surface element having a user accessible display surface and an array of openings each having one of said movable pins maintained therein with said enlarged heads of said pins above said display surface and said pin ends below said display surface element; and

actuating means for selectively contacting said pin ends for moving pins maintained at said array of openings at said display surface element between at least first and second positions, a single actuator in said actuating means for moving a number of said pins.

9. The apparatus of claim 8 wherein said matrix of stacked elements includes means for holding said elements so that said pin retention element is selectively movable relative to said display surface element allowing relatively free pin movement during one stage of operation with said pin retention element at a first position and locking said pins in position during another stage of operation with said pin retention element at a second position.

10. The apparatus of claim 8 wherein said actuating means includes one of a one-dimensional scanned actuator array, a raster scanning array, or a vector drawing system.

11. The apparatus of claim 8 further comprising a flexible cover over said matrix of stacked elements at said display surface element, said enlarged heads of said pins bearing thereagainst.

12. The apparatus of claim 8 further comprising one of a roller mechanism or a plate element in said matrix for movement of said pins to a default position preparatory to resetting the display.

13. The apparatus of claim 8 further comprising means for creation of permanent copies of a display at said display surface of said display surface element.

14. The apparatus of claim 8 wherein at least one of said display surface element and said pin retention element of